FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SURGICALLY CORRECTED POSTERIOR COLUMN WITH WALL ACETABULAR FRACTURES
A SHORT-TERM FOLLOW UP

1VIRAJ NALAM, 2VIGNESH GADUPUDI

1M.S., 2M.D.
SRI RAMACHANDRA MEDICAL COLLEGE
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AO</td>
<td>ARBEITGEMEINSCHAFT FUR OSTEOSYNTHESEFRAGEN</td>
</tr>
<tr>
<td>MDA</td>
<td>MERLE D AUBIGNE</td>
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<tr>
<td>HHS</td>
<td>HARRIS HIP SCORE</td>
</tr>
<tr>
<td>ATLS</td>
<td>ADVANCED TRAUMA LIFE SUPPORT</td>
</tr>
<tr>
<td>ER</td>
<td>EXTERNAL ROTATION</td>
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<tr>
<td>IR</td>
<td>INTERNAL ROTATION</td>
</tr>
<tr>
<td>CT</td>
<td>COMPUTED TOMOGRAPHY</td>
</tr>
<tr>
<td>THA</td>
<td>TOTAL HIP ARTHROPLASTY</td>
</tr>
<tr>
<td>ORIF</td>
<td>OPEN REDUCTION AND INTERNAL FIXATION</td>
</tr>
<tr>
<td>HO</td>
<td>HETEROTOPIC OSSIFICATION</td>
</tr>
<tr>
<td>PC</td>
<td>POSTERIOR COLUMN</td>
</tr>
<tr>
<td>PW</td>
<td>POSTERIOR WALL</td>
</tr>
<tr>
<td>TV</td>
<td>TRANSVERSE</td>
</tr>
<tr>
<td>AW</td>
<td>ANTERIOR WALL</td>
</tr>
<tr>
<td>AC</td>
<td>ANTERIOR COLUMN</td>
</tr>
<tr>
<td>DC</td>
<td>DOUBLE COLUMN</td>
</tr>
<tr>
<td>TS</td>
<td>T SHAPE</td>
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<tr>
<td>PHTV</td>
<td>POSTERIOR HEMI TRANSVERSE</td>
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</tbody>
</table>
ABSTRACT

INTRODUCTION
Incidence of pelvic fractures is 37 per 1 lakh population per year. Among them acetabular fractures account to around 3 per lakh population. Due to high energy injuries in younger individuals polytrauma is frequently associated which affects morbidity of the patient significantly whereas older individuals present with an isolated acetabular fracture. Acetabulum being important weight bearing surface of hip joint, fixation of these fractures is extremely important to provide congruous stable painless hip joint to provide early mobilization and to avoid secondary osteoarthritis.

AIM
To study the clinical and radiological outcomes after the posterior wall with column acetabular fractures corrected by surgical fixation.

MATERIALS AND METHODS
The purpose of this prospective clinical observation was to evaluate outcomes in patients with acetabular fracture treated surgically. We analyzed 11 displaced acetabular fractures managed surgically between 2018 - 2020 in SRMC, Chennai. Patients were followed for a period of 6 months - 12 months; without any patient lost to follow-up. Outcome in these patients was evaluated using Harris Hip Score (HHS) and Matta radiological criteria.

RESULTS
Of the total of 11 patients, 11 were followed for a mean of 1 year; none were lost to follow-up postoperatively. Dislocation of the hip was recorded in 6 patients. 3 foot drops observed in my study were preoperatively associated and no iatrogenic foot drop occurred. All three cases associated with hip dislocations. Surgical
site infection occurred in two cases. No any implant failure or non-union observed in my study. The results according to the modified MERLE D’ AUBIGNÉ AND POSTEL SCORING SYSTEM was excellent in 3 patients, very good in 2 patients, good in 4 patients, fair in 1 and poor in 1. Mean HARRIS HIP SCORE at end of 3mon/6mon/12mon was 47.08/64.18/87.45

CONCLUSION
Gold standard treatment is open reduction and internal fixation in dedicated centers by experienced surgeons as soon as possible. Early intervention in case of hip dislocation is important to prevent the chondral damage. Early ORIF is necessary to provide accurate anatomic reduction and joint congruency which can prevent or delay future requirement of THA. Posterior wall and dome of acetabulum parts are most important to reconstruct as they are the weight bearing structures. Associated injuries must be addressed well to improve the overall functional scores. Poor functional results are due to increased age/delay in surgery/complex fracture/associated transverse component fracture/inappropriate reduction/dome incongruency/polytrauma.

INTRODUCTION
Incidence of pelvic fractures is 37 per 1 lakh population per year. Among them acetabular fractures account to around 3 per lakh population. Motor vehicle accident injuries are most common cause for acetabular fractures in young individuals whereas in older individuals trivial trauma can cause them. This explains the reason for bimodal age distribution with first peak in 3rd decade due to high energy fractures and second peak in 6th decade due to low energy fractures. Due to high energy injuries in younger individuals polytrauma is frequently associated which affects morbidity of the patient significantly whereas older individuals present with an isolated acetabular fracture.

Dash-board injury to the flexed knee is the commonest causes for the posterior acetabular wall fractures which are usually associated with posterior hip dislocations. Neurological injury to sciatic nerve occurs in 30% of cases most of them which are partial injury commonly involving the peroneal component rather than tibial component. Increased risk of sciatic nerve injury in case of posterior acetabular fractures which require posterior and extensive surgical approach with retraction of sciatic nerve. Since the advent of mandatory seat belt use, there has been significant reduction in the incidence of acetabular fractures.
Acetabular fractures usually occurs in polytrauma patients which causes increased morbidity in them and hence results in poor outcomes. Non operative treatment of acetabular fractures results in early hip arthritis which increases the requirement of hip replacement surgery. Hence acetabular fractures demand early intervention and accurate surgical fixation. The best results in acetabular fracture surgery can be achieved only by experienced surgeons trained in this injuries. Fractures of the posterior wall are the most common type of acetabular fractures accounting for approximately 25% of all acetabular fractures.

Meta-analysis done by P.V. Giannoudis et al. in a total of 3670 fractures over the period of 40 years found that acetabular fractures occurred more commonly in young active male population.

In a study done by Pascarella et al. in 2017 about isolated posterior wall fractures, anatomic reduction was obtained in 115 (95%) cases, satisfactory in remaining 6 (5%) cases. MDA score observed as excellent in 45 hips (40.2%) good in 52 hips (46.4%) poor in only 8 hips (7.1%). They concluded that prompt reduction of hip dislocation and accurate fracture reduction are key factors in better outcome whereas associated injuries and nerve palsy have negative impact on outcomes. In study done by Briffa et al., 52.1% cases with isolated posterior wall fractures had excellent outcomes but only 28.57% of cases with posterior wall with transverse column fractures had excellent outcomes. T-shaped fractures combined with a fracture of the posterior wall seem to represent the worst-case scenario in many studies. The associated transverse fracture makes the reduction difficult and hence inappropriate congruency results in poor outcomes. Hence isolated posterior wall fractures may have good prognosis but when combined with other acetabular injuries results in poor outcomes.

Due to the close proximity of the sciatic nerve to the posterior acetabular wall and column, sciatic nerve is injured in most of the traumatic posterior dislocations. Those with a combined posterior wall fracture with traumatic dislocation of hip and sciatic nerve palsy had a statistically significant negative impact on outcome according to many studies. Hence it is important to reduce and fix posterior acetabular fractures immediately for better outcomes.

The biology of the fracture (primary articular cartilage damage) has now become the limiting factor, which may require primary arthroplasty in selected cases as stated in study by H.J. Kredal et al. Hip dislocations occur with posterior acetabular fractures which results in subchondral impaction, intra-articular fragments and comminution which results in severe cartilage damage thus resulting in poor functional outcomes and necessitates the hip
replacement surgery in few cases.

Acetabulum being important weight bearing surface of hip joint, fixation of these fractures are extremely important to provide congruous stable painless hip joint to provide early mobilization and to avoid secondary osteoarthritis. However due to the reasons of complex anatomy of acetabulum, complicated fracture pattern, difficulty to access fracture site and associated polytrauma adds onto difficulty in positioning the patient intra-operatively. As the posterior wall and column are most commonly involved and contribute to the major weight bearing part of the hip joint, this study conducted to analyze the short term outcome after surgical fixation of the posterior wall and column acetabular fractures.

**AIM OF THE STUDY**

To study the clinical and radiological outcomes after the posterior wall with column acetabular fractures corrected by surgical fixation.

**OBJECTIVES**

1. To study the advantages and disadvantages of surgically corrected posterior acetabular fractures.
2. To study the occurrence of hip arthritis, sciatic nerve injury and associated vascular injuries following surgery.
MATERIALS AND METHODS

• STUDY DESIGN - LONGITUDINAL STUDY
• STUDY INSTITUTION - SRI RAMACHANDRA INSTITUTE OF HIGHER EDUCATION AND RESEARCH, PORUR.
• TIME OF STUDY - MAY 2018 to AUG 2020
• TYPE OF STUDY - PROSPECTIVE STUDY
• SAMPLE SIZE - PERIOD STUDY
• FOLLOW UP - 6 MONTHS - 1 YEAR

INCLUSION CRITERIA
➢ SKELETALLY MATURE ADULTS (AGE >= 18 YEARS)
➢ ACUTE FRACTURES <= 3 WEEKS OLD
➢ POSTERIOR WALL ACETABULAR FRACTURES + POSTERIOR COLUMN FRACTURES
➢ POSTERIOR WALL ACETABULAR FRACTURES WITH OTHER LONG BONE INJURIES
➢ FRACTURE DISLOCATION OF HIP JOINT INVOLVING POSTERIOR WALL ACETABULAR FRACTURES

EXCLUSION CRITERIA
➢ AGE <= 18 YEARS
➢ FRACTURES > 3 WEEKS OLD
➢ ASSOCIATED OTHER PELVIC INJURIES
➢ PATHOLOGICAL FRACTURES
➢ PREVIOUS HIP SURGERIES

Patients who met all these eligibility criteria he/she was explained about the aims and objectives of this study and were included after obtaining informed written consent.

Patients and methods
We analyzed 11 displaced acetabular fractures managed surgically between 2018-2020 by the different surgeons in SRMC, Chennai. Patients
were followed for a period of 6 months - 12 months; without any patient lost to follow-up.

An acetabular admission protocol for all local and inter-hospital transfer was followed; data recorded included the mechanism of injury, classification of the fracture, associated injuries, complications and comorbidities. Standard plain radiographs, including anteroposterior pelvis, obturator oblique and iliac oblique views, as well as CT scans, were obtained to assess and classify all fractures preoperatively according to Judet et al.\(^{26}\) (Fig 6).

- AP view - to identify acetabular injury and other associated pelvic injuries (Fig 8 A)
- Iliac view - to assess the posterior column and anterior wall (Fig 8B)
- Obturator view - to assess anterior column and posterior wall (Fig 8C)

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**Fig 1: The six fundamental radiographic landmarks of Leutorel**

1. Posterior wall  
2. Anterior wall.  
3. Dome.  
4. Teardrop.  
5. Posterior Column.  
6. Anterior Column.
The iliopectineal line represents the pelvic brim and is the radiological landmark for anterior column.

The ilioischial line represents the posterior portion of quadrilateral surface and is the radiological landmark for posterior column.

Anterior rim (lateral margin of anterior wall) is slightly horizontal and medial to the posterior rim (lateral margin of posterior wall).

Tear drop has medial and lateral limbs which represent the obturator canal and antero inferior acetabular wall respectively. Increased gap of the medial femoral surface to the tear drop is seen in hip dislocation.

Fracture line passing through the roof of acetabulum means it involves the weight bearing portion.

CT evaluation (Fig 9):

Preoperatively CT scans done to assess

A. Articular incongruency and step-off
B. Size and number of posterior wall fragments
C. Marginal impaction
D. Intraarticular fragments
E. Rotation and displacement of columns.
Axial CT can be used for better imaging of the fracture pattern.

**Fig 2: CT sections showing acetabular fracture patterns**

**Timing of surgery**

Any associated hip dislocation was considered as emergency and taken up for immediate hip closed reduction under sedation. Skeletal traction was applied until definitive fixation is done to prevent recurrence of hip dislocation and further cartilage damage. Irreducible reductions/incarcerated intra articular fragment/ unstable posterior dislocations/ progressive sciatic nerve palsy are taken for emergency surgery.

Average time duration in our study was 3-5 days after injury once the general condition of patient is optimized. Delay in surgery did not exceed more than 14-21 days beyond which would result in unsatisfactory reductions.
Factors considered in our cases to take up for surgery
1. Joint incongruency with >2mm articular step-off.
2. Posterior wall fractures involving >50% of surface.
3. If posterior wall fracture fragment <50%, then intraoperative joint stability is assessed with hip in 90 deg flexion.
4. Roof arc angle <45%- medial/anterior/ posterior roof arc (According to MATTA) had increased involvement of dome of the acetabulum weight bearing portion. Hence were taken up for surgery.
5. Incarcerated fragments/ marginal impaction of femoral articular surface.

Operative protocol: The primary goal was anatomical reduction with stable fixation as early as possible. Intra-operatively, patients were routinely catheterized. No intra-operative nerve monitoring was used. Single surgical approach used was Kocher Langenbeck approach for all of our cases which had posterior acetabular fractures. Trochanteric and posterior wall osteotomies were not done in any of our cases.

Intra-operative fluoroscopy was used to assess reduction and ensure that the metal work did not transgress the hip joint. Both accuracy of reduction and minimal extensive approaches were taken as criteria for better outcomes. None of our patients required immediate arthroplasty of the hip. In patients with a pre-operative sciatic nerve palsy, intra-operative exploration of the nerve was undertaken.

Position and approach

- All our patients were put in lateral decubitus position (Fig 3).
- Kocher-Langenbeck approach was used in all cases (Fig 4, 5).
**Reduction technique**

- Intra-operative traction was given to reduce the fracture fragments having capsular attachments (one in sciatic buttress and other in femoral head (Fig 6).
- Joint space was palpated for any intra-articular fragments which were removed / marginal impaction for which bone grafting was done.
- Ball spike was used to hold fracture fragments in place and stabilized with kirshner wires.
- Headless compression screws were used as LAG screw to provide compression at fracture site.

![Intra operative traction using Steinman pin](image)

**Fig 6: Intraoperative traction using Steinman pin**

- Recon plates were contoured to accommodate posterior acetabular surface (Fig 14 a/b).
- Posterior buttress plates were applied and fixation with cortical screws above into ilium and below into ischium.
- Intraoperative fluoroscopy was used to check any screw penetration into joint space.

![Acetabular Recon plates](image)

**Fig 7: Acetabular Recon plates**

- In case of column with wall fractures-first fixation of column was done followed by fixation of wall.
In associated transverse component fracture, two cortical screws were inserted into both columns and screw-holding forceps was applied and rotational displacement was corrected. LAG screw was then applied through the plate into anterior column for increased stability (Fig 15 a/b).

**Optimal position for a lag screw.**

**Screw penetrating into cotyloid fossa.**

**Fig 8: LAG screw in acetabular surgery**

### Assessment of reduction and fixation

- The quality of reduction was noted intra-operatively and graded by the senior surgeon as anatomical, acceptable or non-anatomical (Table 4). The reduction was categorized as anatomical when all imperfections were corrected and noted by direct visualization and/or intra-operative imaging when the approach precluded direct visualization of the fracture. Hip movements and stability in all planes were checked. Digital palpation along quadrilateral surface through greater or lesser sciatic notch done to check adequacy of reduction.

- An acceptable reduction was where the hip was congruent. A nonanatomical reduction was noted when there was still residual subluxation of the hip and loss of parallelism of the femoral head in relation to the roof of the acetabulum.

Post-operatively, anteroposterior pelvic and Judet views were obtained to categorise the quality of the reduction into three groups: anatomical, congruent and incongruent, using Matta’s radiological principles. The reduction was categorized as anatomical if all fracture gaps and steps had been removed intra-operatively, and postoperative films showed restoration of all five anatomical lines (ilioinguinal, ilio-pectineal, dome, posterior wall and anterior wall) with the head centered and parallel beneath the acetabular roof. A congruent reduction is best judged on the anteroposterior film, which is useful in assessing the hip with reference to both the congruency and anatomy of the contralateral normal joint. Patients with poor restoration of the five pelvic lines, inward sub-luxation of the hip and loss of parallelism were included
in the incongruent group.

**Postoperative protocol**

Post-operatively, to reduce the risk of heterotopic ossification, all patients received indomethacin 50 mg three times a day for two weeks, reducing to 25 mg three times a day for four weeks, combined with a pain management protocol. Anticoagulation prophylaxis involved the administration of low molecular weight heparin pre-, peri- and post-operatively. All patients were subsequently prescribed aspirin for three months.

In bed mobilization started as early as 24-48 hrs. Non weight bearing is encouraged once the general condition is optimized and continued for 2 months after surgery. Full weight bearing was started 3 months after surgery when union is confirmed radiologically.

All patients were followed up clinically and radiologically at six and 12 weeks, 6 months and one year, Functional outcome scores, the HHS (Table 1) at 3mon/6mon/1year and the modified Merle D’Aubigné and Postel score (Table 2) were recorded at the final follow-up.
Table 1: HARRIS HIP SCORE

<table>
<thead>
<tr>
<th>A. Pain</th>
<th>B. Gait/limp</th>
<th>C. Support</th>
<th>D. Distance</th>
<th>E. Stairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>None-44</td>
<td>None-11</td>
<td>None-11</td>
<td>Unlimited-11</td>
<td>Normal-4</td>
</tr>
<tr>
<td>Slight</td>
<td>Slight-8</td>
<td>Cane for long walks-7</td>
<td>6 blocks-8</td>
<td>Normal with banister-2</td>
</tr>
<tr>
<td>Occasional-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>Moderate-5</td>
<td>Cane fulltime-5</td>
<td>2 or 3 blocks -5</td>
<td>Any method-1</td>
</tr>
<tr>
<td>Normal activity-30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate, activity concessions-20</td>
<td>Unable to walk-0</td>
<td>Crutch-4</td>
<td>Indoors only -2</td>
<td>Unable-0</td>
</tr>
<tr>
<td>Marked, severe concessions-10</td>
<td>Two canes-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totally Disabled-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy -4</td>
<td>Any chair 1 hour- 5</td>
<td>Able-1</td>
<td>Absence of all 4 deformities -4</td>
<td>Full -5</td>
</tr>
<tr>
<td>With difficulty-2</td>
<td>High chair 30 minutes3</td>
<td>Not able to use -0</td>
<td>Presence of 1 deformity -0</td>
<td>Partial-4</td>
</tr>
<tr>
<td>Unable-0</td>
<td>Unable to sit for 30 minutes-0</td>
<td></td>
<td></td>
<td>Limited-2</td>
</tr>
</tbody>
</table>
# Harris Hip Score

### General Information

**Patient Initials:**

**Visit Date:**

**Operative Side:**
- **Right**
- **Left**

**Visit:**
- **Pre-Op**
- **6 Weeks**
- **1 Year**
- **2 Year**
- **5 Year**

## I. Pain

**A. Pain**
- None, or ignores it
- Slight, occasional, no compromise in activities
- Mild, no affect on average activities, rarely moderate pain with unusual activity, may take aspirin
- Moderate pain, tolerable but makes concessions to pain. Some limitations of ordinary activity or work. May require occasional pain medication stronger than aspirin
- Marked pain, serious limitation of activities
- Totally disabled, crippled, pain in bed, bedridden

## II. Function / Gait

**B. Limp**
- None
- Slight
- Moderate
- Severe or unable to walk

**C. Support**
- None
- Cane, long walks
- Cane, most of the time
- One crutch
- Two crutches or walker
- Two or three blocks

**D. Distance Walked**
- Unlimited
- Six blocks
- Bed and chair only
- Two or three blocks

## III. Functional Activities

**E. Stairs**
- Normally without using a rail
- Normally using a railing
- In any manner
- Unable to use stairs

**F. Soles / Shoes**
- With ease
- With difficulty
- Unable

**G. Sitting**
- Any chair, 1 hour
- High chair, 1/2 hour
- Unable to sit comfortably in any chair

## IV. Range of Motion

**H. Public Transportation**

**I. Deformity**
- Fixed adduction
- Fixed internal rotation in extension
- Leg length discrepancy
- Pelvic flexion contracture

### Permanent (Fixed) Flexion

### 2. Flexion

### 3. Abduction

### 4. Adduction

### 5. External Rotation in Extension

### 6. Internal Rotation in Extension

## V. Comments

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Table 2: MERLE D AUBIGNE’ AND POSTEL METHOD SCORE

<table>
<thead>
<tr>
<th>Points</th>
<th>PAIN</th>
<th>MOBILITY</th>
<th>ABILITY TO WALK</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Intense and permanent</td>
<td>Ankylosis of the hip in abnormal position.</td>
<td>Not able to walk.</td>
</tr>
<tr>
<td>1</td>
<td>Severe and disturbed sleep.</td>
<td>Ankylosis in normal position.</td>
<td>Only with crutches.</td>
</tr>
<tr>
<td>2</td>
<td>Severe when walking and prevents any activity.</td>
<td>Flexion &lt;40</td>
<td>Only with 2 canes.</td>
</tr>
<tr>
<td>3</td>
<td>Severe but tolerated with limited activity.</td>
<td>Flexion between 40 and 60.</td>
<td>Limited with one cane (&lt; 1 hr)</td>
</tr>
<tr>
<td>4</td>
<td>Mild pain when walking.</td>
<td>Flexion between 60 and 80.</td>
<td>Long time with cane, Limited without cane.</td>
</tr>
<tr>
<td>5</td>
<td>Mild pain but with normal activity.</td>
<td>Flexion between 80 and 90, o abduction of 15.</td>
<td>Without cane but slight limp.</td>
</tr>
</tbody>
</table>

(E Excellent 18)-(Very Good 17)-(Good 15/16)-(Fair 13/14)-(Poor<13)
Table 3: MATTA RADIOLOGICAL CRITERIA

<table>
<thead>
<tr>
<th>Displacement.</th>
<th>Grade of reduction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero or 1mm</td>
<td>Anatomical.</td>
</tr>
<tr>
<td>2-3mm</td>
<td>Satisfactory.</td>
</tr>
<tr>
<td>&gt;3mm</td>
<td>Unsatisfactory.</td>
</tr>
</tbody>
</table>

- The plain radiographs made after surgery were reviewed to assess reduction according to Matta et al. (1986) criteria (Table 3).
- **Ethical considerations**: Study was approved by the institutional human ethics committee. Informed consent was obtained from all the study participants. Confidentiality of the study participants was maintained.
- **Statistical method**: The statistical analysis was performed using the SPSS software version 19. The descriptive analysis was performed to estimate Mean, SD, and percentages. Unpaired t test was employed to compare mean values between the groups. Chi- square test was used to compare the percentage between the groups. The statistical significance was fixed at 5%.

**CASE ILLUSTRATIONS**

**CASE 1**

**AGE**: 48 YEARS/M **MOI**: RTA.

**DIAGNOSIS**: LEFT ISOLATED ACETABULAR POSTERIOR WALL FRACTURE.

**SURGERY**: 1. LEFT HIP CLOSED REDUCTION. 2. LEFT ACETABULAR RECON PLATING.

**IMPLANTS USED**: 8 HOLE RECON PLATE

**HIP DISLOCATION**: PRESENT.

**FOOT DROP**: ABSENT.
Preop Xray

Prereduction CT images

Immediate Post-OP (Matta’s Criteria - Anatomical Reduction)
3 MONTHS FOLLOW UP

ONE YEAR FOLLOW UP

MDA-EXCELLENT.

HARRIS HIP SCORE 3 MONTHS - 56 / 6 MONTHS - 70 / 1 YEAR - 95

CASE 2
AGE:-- 30 YEARS/M
MOI:-- RTA.
DIAGNOSIS:-- LEFT ACETABULAR POSTERIOR COLUMN FRACTURE.
SURGERY:-- LEFT ACETABULAR RECON PLATING. IMPLANTS USED:-- 8 HOLE PELVIC RECON PLATE. HIP DISLOCATION:-- ABSENT.
FOOT DROP:-- ABSENT.
COMPLICATION:-- LIMB LENGTH DISCREPENCY.
Immediate Post-OP (Matta’s Criteria-Anatomical Reduction)

3 MONTHS FOLLOW UP

ONE YEAR FOLLOW UP

MDA-VERY GOOD.
HHS - 3 MON -55/ 6 MON -66/ 1 YEAR-88
CASE 3
AGE: 23 YEARS/M
MOI: RTA.
DIAGNOSIS: RIGHT ISOLATED POSTERIOR WALL ACETABULAR FRACTURE.
SURGERY: RIGHT ACETABULAR RECON PLATING
IMPLANTS USED: 7 HOLE RECON PLATE HIP
DISLOCATION: ABSENT.
FOOT DROP: ABSENT.
Immediate Post-Op (Matta’s Criteria Anatomic Reduction)

3 MONTHS FOLLOW UP

HARRIS HIP SCORE 3 MON -54/ 6 MON -68/ 1 YEAR-94MDA-EXCELLENT

CASE 4
AGE:- 24 YEARS/MMOI:- RTA
DIAGNOSIS:- LEFT ISOLATED POSTERIOR WALL ACETABULAR FRACTURE + LEFT PATELLA FRACTURE
SURGERY:- LEFT ACETABULAR RECON PLATING.
IMPLANTS USED:- 8 HOLE RECON PLATE.
HIP DISLOCATION:- PRESENT.
FOOT DROP:- PRESENT.
ASSOCIATED INJURY:- LIVER LACERATION.
Immediate Post-Op (Matta’s Criteria Anatomic Reduction)
3 MONTHS FOLLOW-UP

6 MONTHS FOLLOW-UP

9 MONTHS FOLLOW-UP

1 YEAR FOLLOW-UP

HARRIS HIP SCORE- 3 MON -54/ 6 MON – 71/ 1 YEAR -99MDA-EXCELLENT

CLINICAL PICTURES
CASE 5
AGE: 19 YEARS/M
MOI: RTA
DIAGNOSIS: LEFT ACETABULAR POSTERIOR WALL WITHCOLUMN FRACTURE AND TRANSVERSE + LEFT TIBIA FRACTURE + LEFT FEMUR FRACTURE.
SURGERY: LEFT FEMUR RETROGRADE NAILING + LEFT ACETABULUM RECON PLATING.
IMPLANTS USED: 10 HOLE PELVIS J-PLATE
HIP DISLOCATION: ABSENT
FOOT DROP: ABSENT
COMPLICATIONS: FEMUR NON UNION

PRE OP XRAY

PREOP CT IMAGES
IMMEDIATE POST OP MATTA’ S CRITERIA - ANATOMIC REDUCTION

IPSILATERAL FEMUR NAILING

3 MONTHS POST-OP

6 MONTHS POST-OP
1 YEAR POST-OP

HHS - 3 MON -50/ 6 MON -62/ 1 YEAR -80MDA - FAIR

CLINICAL PICTURES
CASE 6
AGE:- 52 YEARS/F
MOI:- RTA.
DIAGNOSIS:- LEFT ACETABULAR POSTERIOR WALL WITH TRANSVERSE FRACTURE + LEFT DISTAL RADIUS FRACTURE.
SURGERY:- LEFT ACETABULAR RECON PLATING.
IMPLANTS USED:- 8 HOLE RECON PLATE + HEADLESS COMPRESSION SCREWS.
HIP DISLOCATION:- PRESENT.
FOOT DROP:- ABSENT.
COMPLICATIONS:- DISUSE OSTEOPENIA.
PREOP XRAY

PREOP CT IMAGES
Immediate Post OP Matta’s Criteria - Unsatisfactory reduction

6 MONTHS POST-OP

1 YEAR POST-OP

MDA- GOOD.
HHS 3 MON.-28 / 6 MON.-52 / 1 YEAR-74
CASE 7
AGE:- 44 YEARS/M. MOI:- RTA.
DIAGNOSIS:-- RIGHT COMMINUTED POSTERIOR WALL + TRANSVERSE ACETABULAR FRACTURE + RIGHT PATELLA FRACTURE + RIGHT PROXIMAL TIBIA FRACTURE.
SURGERY:- RIGHT ACETABULAR RECON PLATING + RIGHT PATELLA PLATING + RIGHT PROXIMAL TIBIA PLATING.
IMPLANTS USED:- 6 HOLE AND 8 HOLE RECON PLATES. HIP DISLOCATION:- ABSENT.
FOOT DROP:- ABSENT.
COMPLICATIONS:- SURGICAL SITE INFECTION.

PRE OP XRAY

PREOP CT IMAGES
Immediate Post-OP Matta’s Criteria - Satisfactory

3 MONTHS POST-OP

6 MONTHS POST-OP

1 YEAR FOLLOWUP

HHS-3 MON-50 / 6 MON-67 / 1 YEAR-93MDA- VERY GOOD
CLINICAL PICTURES
CASE 8
AGE: 33 YEARS/M MOI: RTA.
DIAGNOSIS: RIGHT POSTERIOR WALL WITH COLUMN ACETABULAR FRACTURE + RIGHT DISTAL FEMUR FRACTURE.
SURGERY: RIGHT ACETABULAR RECON PLATING.
IMPLANTS USED: 10 HOLE RECON PLATE + HEADLESS COMPRESSION SCREWS.
HIP DISLOCATION: PRESENT.
FOOT DROP: ABSENT.
COMPLICATIONS: KNEE STIFFNESS

PREOP XRAY

PREOP CT IMAGES
MDA-POOR
HARRIS HIP SCORE- 3 MON-49 / 6 MON-58 / 1 YEAR-69
CLINICAL PICTURES
OBSERVATION AND RESULTS

• In our study we observed cases in a prospective manner, all of which were primarily underwent acetabular surgery in Sri Ramachandra hospital, Chennai by different surgeons from May-2018 upto Aug-2020 who all satisfied our inclusion and exclusion criteria for the follow up period of our study. This included a total of 11 cases, none of which were lost to follow up nor reported any deaths.

AGE DISTRIBUTION VS FREQUENCY

Fig 16: Bar chart of age wise distribution of patients (N=11)

In our study a total of 11 acetabular surgeries were included. 3 cases between age group 18 - 27Y,4 cases in age group 28 -36Y,3 cases in age group 37- 45Y and 2 cases in age group 46 - 54Y(Fig 16). The maximum number of patients were from middle age group with youngest age being 19 years and oldest age being 52 years with a mean age of 34.3 years. Follow up period was from 6-12months.
SIDE OF INJURY

Fig17: Pie chart of side distribution (n=11)

In our study, 5 acetabular surgeries were performed on left side and 6 on right side (Fig 17).

GENDER DISTRIBUTION

Fig18: Pie chart of gender distribution (N=11)

In our study of 11 cases, 8 (73%) were males and 3 (27%) were females. The mean age is 34.3 years.
Out of the 11 acetabular fractures, 7 (63.6%) were complex pattern (out of which 5 had transverse fracture component) and 4 (36.4%) were elementary pattern (out of which 1 was isolated posterior column and 3 were isolated posterior wall fractures) (Fig 19). 6 of them had associated dislocation out of which 3 also had preoperative foot drop.

<table>
<thead>
<tr>
<th>JUDET CLASSIFICATION</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Column</td>
<td>1</td>
<td>9.1</td>
</tr>
<tr>
<td>Posterior Wall</td>
<td>3</td>
<td>27.3</td>
</tr>
<tr>
<td>Posterior Wall+ Column</td>
<td>2</td>
<td>18.2</td>
</tr>
<tr>
<td>Posterior Wall+ Transverse</td>
<td>5</td>
<td>45.5</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 5: showing fracture pattern distribution in our study
Fig 20: Associated injuries observed in our study

The associated injuries observed in our study other than acetabular fractures observed in 7/11 (63.6%) of cases which included ipsilateral limb injuries in 4 cases (36.4%) like femur, patella and tibia fractures. Others included head injury, pneumothorax, liver laceration, bladder injury (Fig 20).

Fig 21: Barchart showing the interval between injury-surgery-discharge
In our study the average duration of hospital stay ranges from 7 days to 45 days with an average duration of 17.6 days. The injury to surgery duration varies from as short as 1 day to longest duration of 15 days but never beyond that. On an average patients were taken up for surgery 4.5 days after injury (Fig 21).

**Fig 22: Bar Chart representing BED REST (blue)-NON WEIGHT BEARING (green)-PARTIAL WEIGHT BEARING(yellow) duration**

On an average bed rest was given for period of 2.4 months, NWB for next 2.6 months and PWB for next 1.9 months following which FWB was started (Fig 22).
Fig 23: Bar Chart showing MDA score outcome at 1 year. We observed excellent results in 3 (27.2%), very good in 2 (18.1%), good in 4 (36.3%), fair in 1 (9.1%) and poor in 1 case (9.1%).

Fig 24. Bar Chart showing the HHS of all cases at 3mon/6mon/1 year follow up. At the end of 1 year, 5 cases had HHS above 90, 4 cases had HHS above 80, 1 case had HHS above 70 and 1 case had HHS above 60.
<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGE</strong></td>
<td>11</td>
<td>19</td>
<td>52</td>
<td>34.36</td>
<td>10.70</td>
</tr>
<tr>
<td><strong>Harris_3mn</strong></td>
<td>11</td>
<td>28.00</td>
<td>56.00</td>
<td>47.09</td>
<td>9.70</td>
</tr>
<tr>
<td><strong>Harris_6mn</strong></td>
<td>11</td>
<td>52.00</td>
<td>71.00</td>
<td>64.18</td>
<td>5.74</td>
</tr>
<tr>
<td><strong>Harris_1yr</strong></td>
<td>11</td>
<td>69.00</td>
<td>99.00</td>
<td>87.45</td>
<td>9.40</td>
</tr>
</tbody>
</table>

**Table 6: MEAN and SD of HHS at 3/6/12 months**

**Fig 25:** The bar chart showing the mean harris hip score at 3mon/6mon/1year was 47.09/64.18/87.45 respectively
Fig 26: Bar chart comparing HHS scores between males and females at end of 3mon/6mon/1year

Fig 27: Barchart showing age wise distribution of HHS at end of 3 months/6months /1 year
Fig 28: Clustered Bar Chart Comparing HHS vs fracture pattern

<table>
<thead>
<tr>
<th>Age category</th>
<th>Harris_3 mn</th>
<th>Harris_6 mn</th>
<th>Harris_1yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>18-27 years</td>
<td>52.67</td>
<td>2.31</td>
<td>67.00</td>
</tr>
<tr>
<td>28-36 years</td>
<td>43.50</td>
<td>10.15</td>
<td>63.00</td>
</tr>
<tr>
<td>37-45 years</td>
<td>51.00</td>
<td>1.41</td>
<td>65.50</td>
</tr>
<tr>
<td>45-54 years</td>
<td>42.00</td>
<td>19.80</td>
<td>61.00</td>
</tr>
</tbody>
</table>

*P value 0.56 0.726 0.593

<table>
<thead>
<tr>
<th>Gender</th>
<th>Harris_3 mn</th>
<th>Harris_6 mn</th>
<th>Harris_1yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Male</td>
<td>50.25</td>
<td>7.07</td>
<td>65.25</td>
</tr>
<tr>
<td>Female</td>
<td>38.67</td>
<td>12.22</td>
<td>61.33</td>
</tr>
</tbody>
</table>

^P value 0.249 0.209 0.819

<table>
<thead>
<tr>
<th>Judet Classification</th>
<th>Harris_3 mn</th>
<th>Harris_6 mn</th>
<th>Harris_1yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Posterior Column</td>
<td>55.00</td>
<td>-</td>
<td>66.00</td>
</tr>
<tr>
<td>Posterior Wall</td>
<td>54.67</td>
<td>1.15</td>
<td>69.67</td>
</tr>
<tr>
<td>Posterior Wall+ Column</td>
<td>41.50</td>
<td>10.61</td>
<td>59.00</td>
</tr>
<tr>
<td>Posterior Wall+ Transverse</td>
<td>43.20</td>
<td>10.64</td>
<td>62.60</td>
</tr>
</tbody>
</table>

*One-way ANOVA test, ^Unpaired t test

Table 7: HHS vs age/gender/fracture pattern
The mean Harris hip score of patients in the age group of 18 - 27 years was 52.6/67/91, for 27-36 years was 43.5/63/83.3, for 36-45 years was 51/65/93.5 and for 45-54 years it was 42/61/84.5 at end of 3mon/6mon/1year respectively. P value as calculated by ANOVA test was insignificant when compared with age (p>0.05).

The mean Harris hip score in males was 50.25/62.5/88.25 and in females was 38.67/61.33/85.33 at the end of 3mon/6mon/1year respectively. P value as calculated by unpaired t test was insignificant at 3months, 6 months and 1 year (p>0.05).

<table>
<thead>
<tr>
<th>Age category</th>
<th>MDA Score</th>
<th>Total</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-27</td>
<td>0 1 0 0 2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28-36</td>
<td>1 0 2 1 0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37-45</td>
<td>0 0 1 1 0</td>
<td>2</td>
<td>11.764</td>
<td>0.465</td>
</tr>
<tr>
<td>45-54</td>
<td>0 0 1 0 1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1 1 4 2 3</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-square test, *Statistically significant at p ≤0.05

Table 8: Age VS MDA

MDA scores were calculated in different age groups and p value calculated using chi-square test which was statistically insignificant (p>0.05) (Table 8).
### Table 9: Gender vs MDA

P-value was calculated using the chi square test. MDA score compared with general distribution was found statistically insignificant. ($p > 0.05$) (Table 9).

<table>
<thead>
<tr>
<th>GENDER</th>
<th>MDA SCORE</th>
<th>Total</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1 1 1 2 3</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0 0 3 0 0</td>
<td>3</td>
<td></td>
<td>7.219</td>
</tr>
<tr>
<td>Total</td>
<td>1 1 4 2 3</td>
<td>11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-square test, *Statistically significant at $p \leq 0.05$

### Table 10: Fracture pattern vs MDA

<table>
<thead>
<tr>
<th>Judet Classification</th>
<th>MDA SCORE</th>
<th>Total</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Column</td>
<td>0 0 0 1 0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Wall</td>
<td>0 0 0 3 3</td>
<td></td>
<td></td>
<td>20.625</td>
</tr>
<tr>
<td>Posterior Wall+ Column</td>
<td>1 0 1 0 0</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior Wall+ Transverse</td>
<td>0 1 3 1 0</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chi-square test, *Statistically significant at $p \leq 0.05$
MDA scores were calculated with respect to different fracture patterns and p value was statistically significant (p<0.05) using chi-square test, but this is of no relevance practically because of less number of cases in our study (Table 10).

<table>
<thead>
<tr>
<th>Fracture</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HHS 3mon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>54.7500</td>
<td>.95743</td>
<td>2.408</td>
<td>0.039</td>
</tr>
<tr>
<td>Complex</td>
<td>42.7143</td>
<td>9.74191</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 6mon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>68.7500</td>
<td>2.21736</td>
<td>2.439</td>
<td>0.037</td>
</tr>
<tr>
<td>Complex</td>
<td>61.5714</td>
<td>5.53345</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 1yr</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple</td>
<td>94.0000</td>
<td>4.54606</td>
<td>1.984</td>
<td>0.04</td>
</tr>
<tr>
<td>Complex</td>
<td>83.7143</td>
<td>9.60407</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unpaired t test, Statistical significance fixed at p ≤0.05

**Table 11: HHS vs Simple/ Complex acetabular fracture**

<table>
<thead>
<tr>
<th>Injuries</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HHS 3mon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated acetabular injuries</td>
<td>7</td>
<td>45.0000</td>
<td>11.84624</td>
<td>0.940</td>
<td>0.372</td>
</tr>
<tr>
<td>Associated limb injuries</td>
<td>4</td>
<td>50.7500</td>
<td>2.21736</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 6mon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated acetabular injuries</td>
<td>7</td>
<td>64.0000</td>
<td>6.21825</td>
<td>0.132</td>
<td>0.898</td>
</tr>
<tr>
<td>Associated limb injuries</td>
<td>4</td>
<td>64.5000</td>
<td>5.68624</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 1yr</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated acetabular injuries</td>
<td>7</td>
<td>88.7143</td>
<td>7.22759</td>
<td>0.567</td>
<td>0.584</td>
</tr>
<tr>
<td>Associated limb injuries</td>
<td>4</td>
<td>85.2500</td>
<td>13.42572</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unpaired t test, Statistical significance fixed at p ≤0.05

**Table 12: HHS vs isolated acetabular fracture/ associated limb injury**
<table>
<thead>
<tr>
<th></th>
<th>Hip dislocation</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>Mean</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HHS 3mon</strong></td>
<td>Yes</td>
<td>42.8333</td>
<td>11.66905</td>
<td>4.76387</td>
<td>1.752</td>
<td>0.114</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>52.2000</td>
<td>2.28035</td>
<td>1.01980</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 6mon</strong></td>
<td>Yes</td>
<td>63.1667</td>
<td>7.65289</td>
<td>3.12428</td>
<td>0.622</td>
<td>0.549</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>65.4000</td>
<td>2.40832</td>
<td>1.07703</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HHS 1yr</strong></td>
<td>Yes</td>
<td>85.5000</td>
<td>11.74308</td>
<td>4.79409</td>
<td>0.738</td>
<td>0.480</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>89.8000</td>
<td>6.01664</td>
<td>2.69072</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Unpaired t test, Statistical significance fixed at p ≤0.05

Table 13: HHS vs dislocated hips

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Injuries</th>
<th>Hip dislocation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td>MDA SCORE</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Chi-square 8.839 5.958 5.286

P value 0.065 0.202 0.259

Table 14: MDA vs fracture type/associated limb injury/hipdislocation
Fig 29: Pie chart showing postoperative fracture reduction according to MATTA’S CRITERIA OF FRACTURE REDUCTION

5 cases (45%) showed anatomic reduction, 4 cases (36%) showed satisfactory reduction and 2 cases (18%) showed unsatisfactory reduction. Radiological union was obtained in all cases (100%) at end of one year.
### Table 15: Matta’s criteria of fracture reduction vs fracture type

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Anatomic</th>
<th>Unsatisfactory</th>
<th>Satisfactory</th>
<th>Total</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Column</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
<td>11.340</td>
<td>0.111</td>
</tr>
<tr>
<td>Posterior Wall</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Posterior Wall+ Column</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Posterior Wall+ Transverse</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square test, *Statistically significant at p ≤0.05

---

### Table 16: Matta’s criteria of fracture reduction vs MDA

<table>
<thead>
<tr>
<th>MDA</th>
<th>Matta criteria fracture reduction</th>
<th>Total</th>
<th>Value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anatomic</td>
<td>Unsatisfactory</td>
<td>Satisfactory</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Fair</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Good</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Verygood</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Chi-square test, *Statistically significant at p ≤0.05
Table 17: COMPLICATIONS OBSERVED

Various post operative complications occurred in our study in 6/11(54.5)% of cases which included surgical site infection in 2 cases, arthritis in 3 cases, limb length discrepancy in 2 cases, 1 patient developed disuse osteopenia over entire ipsilateral lower limb. None of the cases had iatrogenic foot drop, although 3 cases had foot drop preoperatively at the time of injury. None of them had implant failure/ non union/ heterotopic ossification/ AVN/ revision surgery/ pulmonary embolism.

<table>
<thead>
<tr>
<th>Intraoperative</th>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Neuro-vascular injury</td>
<td>1. Infection.(2)</td>
<td>1. Hip Stiffness.(3)</td>
</tr>
<tr>
<td>2. Inadequate reduction.(2)</td>
<td>3. DVT.</td>
<td>2. Arthritis.(3)</td>
</tr>
<tr>
<td>4. Screw penetration.</td>
<td>2. Pulmonary Embolism.</td>
<td>3. Heterotopic Ossification</td>
</tr>
<tr>
<td></td>
<td>4. Implant Failure.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Non Union.</td>
<td>5. AVN.</td>
</tr>
<tr>
<td></td>
<td>6. Foot Drop.</td>
<td>5. Limb length discrepancy.(2)</td>
</tr>
<tr>
<td></td>
<td>7. Disuse osteopenia,(1)</td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION

Our study evaluated the short-term results of functional and radiological outcomes of patients who underwent surgical fixation of posterior wall and column acetabular fractures. We evaluated radiological union and functional scores to assess the outcome. In our study, different surgeons with a similar surgical technique and single approach, operated on all our patients. The postoperative protocols followed were identical for all the patients including the rehabilitation. Outcomes of 11 out of 11 surgically fixed acetabular fractures reported (between 2018-2020) followed for short term period about 6mon to 1 year.

The aim of treatment of displaced acetabular fractures is to obtain a stable anatomical reduction with a functional, mobile and pain-free hip. The accuracy of reduction correlates strongly with outcome. A thorough understanding of the fracture pattern as a function of the intricate relationship between the point of impact, the energy involved, the position of the hip and the strength of the bone is essential. Plastic deformation often occurs before fracturing, making fracture lines difficult to judge and reduction occasionally a challenge. It is sometimes necessary to accept extra-articular malalignment to achieve intra-articular anatomical reduction.

Complications are common in acetabular fracture surgery, with 20-25% of patients having poor functional outcome in medium term. The decision to treat a fracture surgically, the surgical approach and accuracy of the reduction are strongly influenced by the surgeons training and expertise. Factors influencing the outcome include delay in surgical treatment, fracture pattern, patients age, associated chondral damage to the femoral head and acetabulum, dislocation at the time of injury, associated neurovascular compromise and preexisting co morbid conditions.
Knowing and understanding the mechanism of injury is the key factor in identifying the potential injuries and providing optimum care in trauma patients. Pre-op evaluation including special views and CT helps in pre-op planning the appropriate approach, minimizing the duration of surgery and reducing the intraoperative and postoperative complications. Kocher-Langenbeck approach is one of the preferred surgical approaches by many pelvic acetabular surgeons and used in majority of fractures not involving anterior wall, anterior column. It is used frequently in about 90% of cases in many studies. In our study, Kocher-Langenbeck approach was used in all cases (100%).

Regarding the delay between the injury and surgery, Zhang et al. conducted study on 17 cases with delay of 6 hours to 9 days using Matta's radiological criteria, he concluded that it is important to minimize the delay in case of transverse with posterior wall fractures to achieve anatomical reduction and to reduce the incidence of arthritis. In our study, mean time between the injury to surgery was 4.5 days (ranges from as early as 1 day to longest of 15 days) but never delayed beyond three weeks which would result in poorest outcome. Complex associated fractures need to be fixed within the first five days, but more simple fractures can be adequately managed up to 15 days after the injury. Beyond this time, results become less satisfactory. In Letournel's original series, the outcome of all reconstructions which were undertaken beyond three weeks was significantly worse.

H.J.Kreder et al. in their study involving 128 acetabular fractures, suggested that anatomical reduction alone was not sufficient to restore the joint function. In addition to articular reduction functional outcome was also determined by fracture pattern, marginal impaction, age of the patient and associated comorbid conditions. They also suggested primary total hip replacement surgery in patients with age more than 50 years for fractures involving marginal impaction with posterior wall comminution. In our study, none of the cases underwent primary total hip replacement. In order to observe number of cases which would require
secondary total hip replacement, mid term or long term follow up study is required.

Matta et al. in 1996 done his study in 259 pts with 262 acetabular fractures operated within 21 days of injury. 255 hips were followed up to 6 years and other 7 which had poor results followed till 2y ears. Our study being a short term study we followed all 11 patients between 6 mon to 1 year. 258 hips operated by single kocher langenbeck/ilio inguinal approach and other 4 by both approaches. Our study is about posterior acetabular fractures and therefore all 11 patients were operated using single Kocher Langenbeck approach. Anatomic reduction was obtained in 185 (71%) in their study whereas anatomic reduction was obtained in 5(46%) of our cases. Loss of anatomic reduction was attributed to the fact of complexity of fractures, associated limb injuries which resulted in delay in injury to surgery time. MDA outcomes were Excellent for 104 (40%), good 95(36%) fair 21(8%) poor 42(16%) in their study whereas excellent for 3(27%) very good for 2(18%) good for 4(36%) fair in 1(9%) and poor in 1(9%) observed in our study. He concluded in his study that anatomic reduction and postoperative congruity between acetabulum and femoral head is the key factor for better outcomes. Accuracy of reduction and best clinical results can be achieved in patients operated within three weeks. In our study average duration from injury to surgery time was 4.5 days.

<table>
<thead>
<tr>
<th>Fracture pattern*</th>
<th>Letournei (ref 69) (%)</th>
<th>Matta (ref 55) (%)</th>
<th>Dakin (ref 71) (%)</th>
<th>Giannou dis (ref 57) (%)</th>
<th>Our study (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV + PW</td>
<td>20.6</td>
<td>23.5</td>
<td>35.3</td>
<td>17.4</td>
<td>45.5</td>
</tr>
<tr>
<td>PW</td>
<td>22.4</td>
<td>8.6</td>
<td>12.9</td>
<td>23.6</td>
<td>27.3</td>
</tr>
<tr>
<td>PW + PC</td>
<td>3.5</td>
<td>3.9</td>
<td>18.8</td>
<td>5.7</td>
<td>18.2</td>
</tr>
<tr>
<td>PC</td>
<td>2.3</td>
<td>3.1</td>
<td>1.2</td>
<td>3.5</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Table 18: Fracture pattern observed in various studies
The distribution of fracture pattern varies in various studies (Table 18), both column involvement being the most common, second being the posterior wall with transverse fractures. In our study posterior wall with transverse fractures in 4/11 cases (36.4%) are most common type observed when compared to 20.6% and 23.5% in leutornel and matta et al study respectively. Isolated posterior wall fractures in our study accounts to about 3/11 cases (27.2%) when compared to Leutornel study (22.4%) and Matta study (8.6%). Although few cases involving anterior column or wall fractures have been operated in our institute but were excluded from our study.

In our study 4 cases had simple fracture pattern (1 isolated posterior column and 3 isolated posterior wall fracture) all of which had anatomic reduction among which three (75%) had excellent and one (25%) had very good outcome. In study by Briffa et al out of 119 cases (75%) who had anatomic reduction showed excellent outcome in 66 (55%) and good outcome in 28 (25%). Unsatisfactory reduction was observed in 2/11 (18%) of our cases both of which showed good outcome whereas in study done by Briffa et al 23 cases (20%) had unsatisfactory reduction among which 4 (17%) had excellent outcome and 5 (22%) had good outcome.

In this series we analyzed the quality of reduction and outcome. We found that accurate assessment of gaps and steps was very difficult unless intra-operative, and so felt that it was justified to use congruency as part of the assessment of reduction, judged on post-operative anteroposterior and oblique radiographs. We found a strong correlation between reduction and outcome. In the congruent group there was a much higher incidence of good outcomes (Table 16). It has been reported that incongruent reduction correlates strongly with a poor outcome, and most poor results were within this group. Recent studies showed that although anatomic reduction is essential for best outcomes but articular cartilage damage plays key role in future outcomes.
<table>
<thead>
<tr>
<th>Author/s</th>
<th>Cases</th>
<th>Mean follow-up (yrs)</th>
<th>Excellent/ good (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bircher</td>
<td>161</td>
<td>11.3</td>
<td>73</td>
</tr>
<tr>
<td>Madhu et al 61</td>
<td>237</td>
<td>2.9</td>
<td>76</td>
</tr>
<tr>
<td>Deo et al 64</td>
<td>74</td>
<td>2.6</td>
<td>74</td>
</tr>
<tr>
<td>Fica et al 73</td>
<td>84</td>
<td>5.5</td>
<td>68</td>
</tr>
<tr>
<td>Rommens et al 74</td>
<td>175</td>
<td>2</td>
<td>76</td>
</tr>
<tr>
<td>Matta et al 55</td>
<td>255</td>
<td>6</td>
<td>76</td>
</tr>
<tr>
<td>Mayo 75</td>
<td>163</td>
<td>3.7</td>
<td>75</td>
</tr>
<tr>
<td>Ruesch et al 76</td>
<td>53</td>
<td>1</td>
<td>83</td>
</tr>
<tr>
<td>Brueton 60</td>
<td>26</td>
<td>2</td>
<td>61</td>
</tr>
<tr>
<td>Our study</td>
<td>11</td>
<td>1</td>
<td>81.8</td>
</tr>
</tbody>
</table>

Table 19: Comparison of published results from other studies

Table 19 showing mean age of follow up in acetabular fracture surgeries in various studies with functional outcomes using MDA score. Our study results of excellent/ good outcome (81.8%) coincides with many of the above mentioned studies by Madhu et al(76%), mayo et al(75%), Rommens et al(76%), ruesch et al(83%).

<table>
<thead>
<tr>
<th>Fracture pattern</th>
<th>Excellent (%)</th>
<th>Good (%)</th>
<th>Fair (%)</th>
<th>Poor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PW</td>
<td>52.17</td>
<td>17.39</td>
<td>4.35</td>
<td>26.09</td>
</tr>
<tr>
<td>PC</td>
<td>14.29</td>
<td>14.29</td>
<td>28.57</td>
<td>42.86</td>
</tr>
<tr>
<td>TV + PW</td>
<td>28.57</td>
<td>21.43</td>
<td>28.57</td>
<td>21.43</td>
</tr>
<tr>
<td>PC + PW</td>
<td>45.45</td>
<td>27.27</td>
<td>0.00</td>
<td>27.27</td>
</tr>
</tbody>
</table>

Table 20: Relative frequencies of fracture pattern vs outcome in 161 patients in Briffa et al study
PW, posterior wall; TV, transverse; PC, posterior column; TS, T-shaped; DC, double column; TV + PW, transverse posterior wall; AC, anterior column; PC + PW, posterior column posterior wall; AC + PHTV, anterior column posterior hemi transverse.

In study done by Briffa et al. 52.1% cases with isolated posterior wall fractures had excellent outcomes but only 28.57% of cases with posterior wall with transverse column fractures had excellent outcomes. In our study excellent outcomes are seen in 99% of cases with isolated posterior wall fractures but only 28% of cases with transverse and posterior wall fracture showed excellent results. The associated transverse fracture makes the reduction difficult and hence inappropriate congruency results in poor outcomes.

Those with a combined posterior wall traumatic dislocation and sciatic nerve palsy had a statistically significant negative impact on outcome. The small subgroup of patients with T-shaped fractures combined with a fracture of the posterior wall seem to represent the worst case scenario in many studies, i.e., a fracture that is difficult to reduce. The biology of the fracture (primary articular cartilage damage) has now become the limiting factor, and the role of primary arthroplasty may become more important in carefully selected cases as stated in study by H.J.Kredal et al.70.

In a study done by Rommens et al.74 in a retrospective method in total of 77 cases who were surgically treated for acetabular fractures were followed up to an average of 45 months. Preoperatively 38 (49.4%) cases had subchondral impaction, intra-articular fragments and commination identified in CT scan. 20 out of 23 cases with moderate MDA score cases and 20 out of 22 cases with moderate HHS score cases have modifiers as mentioned above. In our study one case which had intra-articular incarcerated fragment with marginal impaction had poorest functional score among all. Hence preoperatively identified intraarticular fragments/commination/subchondral impaction have lower midterm scores.
In a study done by Pascarella et al. in 2017 in 121 patients who were operated for isolated posterior wall fractures and were followed up on an average of 53 months, the functional outcome scores were evaluated using MDA,HHS,SF-36 questionnaire and Matta radiological criteria. Anatomic reduction was obtained in 115(95%) cases satisfactory in remaining 6(5%) cases. MDA score observed as excellent in 45hips(40.2%) good in 52hips(46.4%) poor in only 8hips(7.1%) They concluded that prompt reduction of hip dislocation and accurate reduction are key factors in better outcome whereas associated injuries and nerve palsy have negative impact on outcomes. Similar to this in our study anatomic reduction was achieved in all three cases(99%) with isolated posterior wall fractures and showed excellent results in all of them, but when associated with ipsilateral limb injuries only few had excellent to good results.

The various complications observed in our study include sciatic nerve palsy(3/11) but none of them were iatrogenic, osteoarthritis in(3/11), limb length discrepancy in (2/11) surgical site infection in (2/11) and there was no heterotopic ossification or iatrogenic foot drop or non union or implant failure or conversion into THR in any of the case. In a study done by Briffa et al. sciatic nerve injury observed in 12.4% cases when compared to 27.2% in our study. Hip arthritis which is seen in 27.25% of cases in our study compared to 38% of cases as in study by Briffa et al. which may require treatment with hip replacement at later date. The occurrence of avascular necrosis was mentioned as in study by Briffa et al but none of them were observed in our study due to short term period.

Rate of infection is around 5% of acetabular fractures treated operatively. Increased risk of infection in patients with open fractures and morel-Lavalle lesions. None of the cases in our study had open injury. Gastrointestinal and urologic injuries increase risk of infection. In our study, one case which had polytrauma and associated bladder injury developed surgical site infection Haas et al. reported infection in 6 out of 66 cases(9%) who were treated with postoperative irradiation to prevent
heterotopic ossification. 58% (7 out of 12 cases) got infected who underwent embolization who has pelvic arterial injuries.

Morbidly obese individuals have 5 times higher risk of infection. One out of the two patients who developed surgical site infection in our study who is morbidly obese and also had extensive fracture comminution which required more soft tissue dissection and prolonged surgery duration. Infection rates were about 2/11 (18.18%) in our study. In our study both the cases which developed surgical site infection were superficial and were treated with antibiotics and regular dressings. In study done by Briffa et al reported total infection rate about 18% out of which deep infection were 9%. Prophylactic antibiotics were administered in all cases. Neg pressure wound therapy used over closed surgical wound, can treat infection. (Deep infection occurs with Kocher Langenbeck approach because of direct joint exposure and soft tissue stripping from innominate bone. Wound debridement and irrigation for deep seated wounds, culture specific antibiotic treatment for 6 weeks must be administered. Although it is important to limit our soft tissue exposure to minimize infection rates, a number of case s achieved a good outcome with adequate exposure and congruent reduction.

Iatrogenic injury to the sciatic nerve is major complication in acetabular fractures. More commonly occurs in posterior approaches where retraction of sciatic nerve is done. Matta et al. reported 3 - 5% rate of nerve injury in his study(ref 11). Middle brook et al. demonstrated no any reduction of rate of iatrogenic nerve injuries even with the use of intra-operative somatosensory-evoked potential monitoring. Various methods advised to prevent injury are careful patient positioning, maintaining knee flexion, cautious placement of retractor and limited traction on nerve while reduction.

The overall incidence of sciatic nerve palsy was 12% (20) in study by Briffa et al; three were iatrogenic, two of which had a delayed presentation (one to two weeks after surgery) and were caused by a
hematoma in the greater sciatic notch, probably due to anticoagulation. An early post-operative palsy in a nerve that was functioning normally in the immediate post-operative period must be decompressed urgently. Intra-operative monitoring of the nerve was not done in our case as it has no significance in reducing the sciatic nerve injury.\textsuperscript{81,82} In our study, three cases had foot drop, all of them were present preoperatively. These three cases had associated hip dislocation and complex fracture pattern. All were treated conservatively and foot drop splint was given. They showed gradual recovery by end of one year.

Management of nerve injury includes ankle foot orthoses, observation, and physical therapy. Release of the sciatic nerve from the scar tissue and heterotopic bone shown to be helpful. Recovery time ranges from 6 months to 3 years in some cases. Sensory symptoms can recover but motor symptoms may not. In some refractory cases even chronic pain regional syndrome can occur.

The accuracy of fracture reduction is main determinant for the risk of late arthritis (less than 1mm fracture gap have better outcomes).\textsuperscript{4,11} Increased incidence of osteonecrosis occurs in patients with hip dislocation. Matta et al.\textsuperscript{55} emphasized that the primary complication following a fracture of the acetabulum is post-traumatic osteoarthritis. The overall incidence of osteoarthritis in Briffa et al. series was 38%, in our study was 3/11 (27.3%) which was similar to the the 26.6% reported by Giannoudis et al.\textsuperscript{57} in his 2005 meta-analysis. The length of follow-up is critical, and with a longer follow-up arthritis is more likely to develop even in ‘perfectly’ reduced fractures. As our study is short term follow up, accurate results cannot be assessed in this aspect. None of our cases underwent primary or secondary THR \textsuperscript{83,84} shows that results of secondary THA for posttraumatic arthritis after ORIF is inferior to that of primary THA for degenerative arthritis.

Leutornel and Judet\textsuperscript{4} reported 13 deaths after acetabular fracture surgery, 4 of which were due to massive pulmonary embolism\textsuperscript{85} in a study
done in 229 cases of acetabular fractures, thromboembolic prophylaxis regimen was given for all and postoperative DVT occurred in 4% cases, whereas nonfatal pulmonary embolism occurred in 1%. There were no cases of fatal pulmonary thromboembolism. There were no cases of postoperative pulmonary embolism or DVT with our current anticoagulation protocol, namely immediate post-operative prophylactic dose of low molecular weight heparin followed by three months of warfarinisation aiming at an INR of two to three. No formal pre- or post-operative DVT screening was undertaken.

Intra-articular placement of screws is serious complication in acetabular fracture surgery which can lead to posttraumatic arthritis. Leutornel and Judet 54 proposed making full movement of hip through range of motion in complete silence and hear for crepitus 86,87 and they have described intraop and postop radiography to ensure the hardware is placed outside. In our study any screw placement was doubtful as checked using fluoroscopy about intraarticular placement, that was removed and reinserted. Post operative CT scan would help in clear picture of any intraarticular screw placement.

Heterotopic ossification can occur from 18 - 90% after acetabular fracture surgery. Greater than 20% loss of hip movement can be termed as severe HO11 according to Brooker classification for HO 88,89. Radiographic judet views also can be done to assess HO 90. Symptomatic HO requires surgical excision followed by secondary prophylaxis for prevention of recurrence 91. Wu et al. reported 18 acetabular fractures with HO,7 had resection within 6 months,8 between 6 to 12 mon and 3 after 1 year. Recurrence was 29% when done before 6 mon and 36% when done after 6 months but none of the recurrences were clinically significant. Prophylactic postoperative irradiation therapy, indomethacin, or combination was advised for post excision prophylaxis. None of the patients in our study developed heterotopic ossification classified as Brooker III/ IV. The indomethacin, and its efficacy is still controversial. The nil occurrence here is almost certainly attributable to the fact that very few extensile approaches were used, and a thorough debridement was undertaken before closure of the wound.
SUMMARY

• Of the total of 11 patients, 11 were followed for a mean of 1 year; none were lost to follow-up postoperatively.

• The 11 patients had a mean age of 34.3, there were 8 males (72.7%) and 3 females (27.3%). The mechanism of injury was a road traffic accident in all our cases. We observed simple fractures in 4 (36.4%) cases and complex fractures in 7 cases (63.6%).

• The frequency of fracture patterns is shown in Table 5; 7 patients (63.6%) sustained polytrauma and almost half had associated limb fractures.

• Dislocation of the hip was recorded in 6 patients (54.6%). All hips were presented with dislocation except for one which had been closed reduced outside hospital. The mean time to surgery was 4.5 days as illustrated in (Fig 21). The quality of reduction in the immediate postoperative x-rays was shown in (Fig 29). The outcome was better in the anatomical and congruent groups; there were more excellent results recorded in the anatomical group. Out of 5 anatomic reductions achieved, 4 had elementary fracture type. 2 unsatisfactory reductions were observed, both of which had associated transverse component (both of them developed arthritis changes within an year).

• The complications in our study are shown in (Table 16).

• THR was required in none of our patients.

• 3 foot drops (27.3%) observed in my study were preoperatively associated and no iatrogenic foot drop occurred. All three cases associated with hip dislocations. Foot drop was treated conservatively and completely recovered in one case and partially recovered in two cases at end of 1 year.

• Limb length discrepancy associated with slight limp was observed in two cases (18.2%) in my study.

• Surgical site infection occurred in two cases (18.2%) (one had poly trauma and was morbidly obese and other had bladder injury).
• Disuse osteopenia seen in one case (9.1%) (associated with head injury because of which she was prolonged immobilized)
• No any implant failure or non-union observed in my study.
• The results according to the modified MERLE D’ AUBIGNÉ AND POSTEL SCORING SYSTEM was excellent in 3 patients (27.3%), very good in 2 patients (18.2%) good in 4 patients (36.4%), fair in 1 (9.1%) and poor in 1 (9.1%).
• Mean HARRIS HIP SCORE at end of 3mon/6mon/ 12mon was 47.08/64.18/87.45.

In conclusion, a good to excellent functional and radiological outcome was seen in 9/11 patients treated surgically. Complications are common in the short, medium and long term as observed in many studies. There was a disappointingly high infection rate, but a low rate of heterotopic ossification and minimal significant incidence of DVT or pulmonary embolism. No patient developed a DVT when an appropriate prophylaxis regime was used. At present, the aim of the management of displaced acetabular fractures is to achieve anatomical reduction and stable fixation, thereby maintaining the congruence of the joint.
CONCLUSION

• Gold standard treatment is open reduction and internal fixation in dedicated centers by experienced surgeons as soon as possible.
• Early intervention in case of hip dislocation is important to prevent the chondral damage.
• Early ORIF is necessary to provide accurate anatomic reduction and joint congruency which can prevent or delay future requirement of THA.
• Posterior wall and dome of acetabulum parts are most important to reconstruct as they are the weight bearing structures.
• Associated injuries must be addressed well to improve the overall functional scores.
• Poor functional results are due to increased age/ delay in surgery/complex fracture/ associated transverse component fracture/inappropriate reduction/ dome incongruency/ polytrauma.
LIMITATIONS IN THE STUDY

- Our study is not a comparative study.
- Long term study is required to assess the occurrence of hip arthritis and avascular necrosis (incidence of future conversion to THA).
- Postoperative CT scan will help in assessing the accurate anatomic reduction and joint congruency.
- If sample size is more, outcome results can be more reliable.
- Isolated elementary fractures and complex fractures are studied together which may bring fallacies in the results.


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